TENNESSEE DEPARTMENT OF EDUCATION
FIRST TO THE TOP

Plumbing Systems

Primary Career Cluster:	Architecture & Construction
Consultant:	Rachel Allen, (615) 532-2835, Rachel.Allen@tn.gov
Course Code(s):	6082
Prerequisite(s):	*Mechanical, Electrical, & Plumbing Systems* (6161)
Credit:	1
Grade Level:	11-12
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
Programs of Study and Sequence:	This is one of the third-level course options in the *Mechanical, Electrical, & Plumbing Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://site1.tnskillsusa.com/ Brandon Hudson, (615) 532-2804, Brandon.Hudson@tn.gov
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit http://tn.gov/education/cte/work_based_learning.shtml.
Available Student Industry Certifications:	Students completing the course through an NCCER accredited program may receive module credit for NCCER.
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	501, 502, 527, 567, 580, 592, 701, 703, 707
Required Teacher Certifications/Training:	None
Teacher Resources:	http://www.tn.gov/education/cte/ArchitectureConstruction.shtml

Course Description

Plumbing Systems prepares students for careers in plumbing across a variety of residential and commercial settings. Upon completion of this course, proficient students will be able to implement safety procedures and tools to perform operations with plumbing systems. Students will be able to explain how drain, waste, and vent (DWV) systems, water distribution systems, and plumbing fixtures work and apply proper tools and procedures to perform operations with plumbing piping, including measuring, cutting, joining, supporting, and hanging various types of pipe. Students will read and

interpret drawings, specifications, and diagrams to determine materials needed to complete a plumbing project. Standards in this course also introduce basic maintenance and troubleshooting procedures and expand on principles of the construction industry, delving deeper into business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study. Standards in this course are aligned with Tennessee State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee State Standards in Mathematics, and Tennessee State Standards in Chemistry I, Physics, Physical Science, and Environmental Science, as well as the National Center for Construction Education and Research (NCCER) Curriculum.*

Program of Study Application

This is one of the third-level course options available in the *Mechanical, Electrical, & Plumbing Systems* program of study. This course can feed into a fourth-level *Construction Practicum* course in which students apply the skills learned throughout the program of study toward the completion of an in-depth, semester- or year-long work-based learning (WBL) apprenticeship or internship. For more information on the benefits and requirements of implementing these programs in full, please visit the Architecture & Construction website at http://www.tn.gov/education/cte/ArchitectureConstruction.shtml.

Course Standards

Safety

1) Identify safety hazards on a jobsite and demonstrate practices for safe working. Accurately read, interpret, and demonstrate adherence to safety rules, including but not limited to rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. Recognize and employ universal construction signs and symbols such as colors, flags, stakes, and hand signals that apply to construction workplace situations. Research and evaluate construction company safety plans from local industry. Explain the need for jobsite security to prevent liability. Drawing from examples, create and implement a jobsite safety program in the class to ensure safe practices and procedures including jobsite security procedures. (TN Reading 3, 4, 6; TN Writing 2, 4; NCCER 02102-12)

2) Continue to maintain safety records and demonstrate adherence to industry-standard practices regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate safety procedures when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete safety test with 100 percent accuracy. (TN Reading 3, 4; NCCER 02102-12)

3) Follow procedures to work safely around materials. Adhere to responsibilities for employees in material safety as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). For example, obtain an MSDS for a given material from a supplier in the community. Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper

materials-handling equipment. Describe hazards involved with plumbing work, including working in confined spaces. (TN Reading 3, 4; NCCER 02102-12)

Tools & Equipment

4) Identify and select the proper tools and accessories, critique the readiness of the tools, use the tools to accomplish the desired tasks, and then return the tools and accessories to their proper storage. Research a new technology recently developed for the plumbing industry. Write persuasively to convince an employer how the use of the technology could benefit the company, citing evidence from resources. For example, describe how a new power tool could improve efficiency for a plumber. (TN Reading 2, 3, 4; TN Writing 1, 7; NCCER 02103-12)

Construction Industry Principles

5) Locate and assess requirements for performing plumbing work including local, state, and national requirements. Interpret plumbing codes, and determine inspection procedures and other applicable portions of the law. Visit the Tennessee Contractor's Licensing Board's website and analyze its policies and requirements. Explain how such policies impact local construction businesses. (TN Reading 2, 3, 4, 9)

6) Consult a variety of sources to describe alternatives to traditional project delivery methods, such as the design-build and construction management-related methods, distinguishing among the roles and relationships of various construction personnel in each scenario. Examine the project delivery method of an actual company. Develop a company profile with supporting graphics the company could share with a client, describing the services provided and explaining the project delivery method used by the company. (TN Reading 2, 3, 4, 5, 7; TN Writing 2, 4; NCCER 44105-08)

Construction Drawings & Specifications

7) Building on knowledge of construction drawings and specifications from *Mechanical, Electrical, & Plumbing Systems*, examine plumbing drawings and identify common plumbing symbols used for the components of pipe assemblies. Read and interpret construction drawings, including detail drawings and equipment schedules, to create a list of materials needed for a given plumbing project. For example, analyze plumbing plans and isometric drawings to determine the materials needed to install a drain, waste, and vent system. (TN Reading 2, 3, 4, 6, 7; TN Writing 2, 9; NCCER 02105-12)

8) Explain the relationship between construction drawings and specifications. Describe how both the construction drawings and specifications provide information about the plumbing system for a building. For example, examine construction drawings and specifications to determine the requirements of hangers and supports for a given plumbing piping system. (TN Reading 1, 2, 4, 5, 6, 7; NCCER 02105-12, 44105-08)

9) Describe processes by which construction professionals obtain clarification from architects regarding construction documents, such as by the use of requests for information (RFI's). Write a request for information (RFI) as would a construction professional to an architect to request

clarification for a detail of the construction documents, such as the selection of a product. (TN Reading 6; TN Writing 4; NCCER 02105-12, 44105-08)

10) Demonstrate the ability to use an architect's scale to measure a component of a scale drawing. Create drawings commonly used in the plumbing trade, including orthographic and isometric sketches. (TN Math G-MD, G-MG; NCCER 02105-12)

Plumbing Math

11) Apply mathematics concepts to solve plumbing problems, distinguishing which principles apply to a given problem. Concepts should include, but are not limited to:
    a. Using the basic rules of right triangles, such as the 3-4-5 ratio, to lay out and check square corners. (TN Math G-SRT; NCCER 02104-12)
    b. Calculating values associated with angles and triangles to determine the run, travel, and rise of an offset. (TN Math G-SRT; NCCER 02104-12)

Plastic Pipe & Fittings

12) Building on the knowledge of plastic piping from *Mechanical, Electrical, and Plumbing Systems*, distinguish among different types of plastic plumbing pipe, fittings, valves, hanging, and support. Draw on textual evidence and observations to describe the material properties of plastic pipe and create guidelines for proper storage and handling requirements. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of plastic plumbing pipe, including ABS, PVC, CPVC, PE, PEX, and PB. Create a list of the appropriate piping materials, tools, and equipment needed for a given plastic piping application including supports and spacing. (TN Reading 1, 2, 4; TN Writing 4; NCCER 02106-12)

13) Read and interpret manufacturer's instructions, construction drawings and specifications, and applicable codes to properly install plastic pipe, including measuring, cutting, joining, and supporting plastic pipe. Utilize the appropriate tools, equipment, PPE, and procedures to safely complete installations. Once installed, pressure test plastic pipe according to local plumbing code to verify installation was properly completed. (TN Reading 2, 3; NCCER 02106-12)

Copper Tube & Fittings

14) Distinguish among different types of copper tube, fittings, valves, hanging, and support. Draw on textual evidence and observations to describe the material properties of copper tube and create guidelines for proper storage and handling requirements. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of copper tube. Create a list of the appropriate piping materials, tools, and equipment needed for a given copper tubing application including supports and spacing. (TN Reading 1, 2, 4; TN Writing 4; NCCER 02107-12)

15) Read and interpret manufacturer's instructions, construction drawings and specifications, and applicable codes to properly install copper tubing, including measuring, cutting, bending, joining, grooving, and supporting plastic pipe. Utilize the appropriate tools, equipment, PPE, and procedures to safely complete installations. Once installed, pressure test copper tube according

to local plumbing code to verify installation was properly completed. (TN Reading 2, 3, 6, 8; NCCER 02107-12)

Cast-Iron Pipe & Fittings

16) Distinguish among different types of cast-iron pipe, fittings, valves, hanging, and support. Draw on textual evidence and observations to describe the material properties of cast-iron pipe and create guidelines for proper storage and handling requirements. Compare and contrast the tools, hazards, and procedures for cutting and joining hub-and-spigot cast-iron pipe and no-hub cast-iron pipe. Create a list of the appropriate piping materials, tools, equipment, and PPE needed for a given cast-iron piping application including selecting the correct supports and spacing. (TN Reading 1, 2, 4; TN Writing 4; NCCER 02108-12)

17) Demonstrate proper procedures to correctly measure, cut, and join cast-iron pipe utilizing the appropriate tools, equipment, and PPE. Describe testing procedures used to check cast-iron piping for leaking joints, as designated in local plumbing code. (TN Reading 2, 3; NCCER 02108-12)

Carbon Steel Pipe & Fittings

18) Distinguish among different types of steel pipe, fittings, valves, hanging, and support. Draw on textual evidence and observations to describe the material properties of steel pipe and create guidelines for proper storage and handling requirements. Compare and contrast the tools, hazards, and procedures for cutting and joining steel pipe. Create a list of the appropriate piping materials, tools, and equipment needed for a given steel piping application including supports and spacing. (TN Reading 1, 2, 4; TN Writing 4; NCCER 02109-12)

19) Read and interpret manufacturer's instructions, construction drawings and specifications, and applicable codes to properly install steel pipe, including measuring, cutting, joining, and supporting steel pipe. Utilize the appropriate tools, equipment, PPE, and procedures to safely complete installations. (TN Reading 2, 3; NCCER 02109-12)

Plumbing Fixtures

20) Describe the features and operating principles of various types of plumbing fixtures, including sinks, lavatories, faucets, bathtubs, showers, and water closets. Analyze the operational procedures of two different water closets, such as a siphon-action water closet and a blow-out water closet. Compare and contrast the functions and benefits of each, citing resources to make a recommendation for a client based on the specific needs of a project. (TN Reading 1, 2, 3, 4, 7; TN Writing 2, 4, 9; TN Physical Science 2; NCCER 02110-12)

Drain, Waste, & Vent (DWV) Systems

21) Study a schematic plan of a typical community sewer system. Citing evidence from a technical description or actual observation of a system, explain how waste moves through a drain, waste, and vent system from the fixture to the environment. Create a graphic illustration to represent the movement of waste from one component to the others in the system. For example, create a

basic diagram of how the waste generated by a clean-up sink in the classroom travels to the local sewage treatment plant. (TN Reading 2, 3, 4, 7; NCCER 02111-12)

22) Demonstrate understanding of the specific roles of various plumbing components in a drain, waste, and vent system by sketching a system model. Label the components, and include a written description of the function of each. Be able to describe the physical principles involved such as gravity and pressure. (TN Reading 2, 3, 4, 5, 7; TN Writing 2; TN Physical Science 1, 4; NCCER 02111-12)

23) Analyze the function of a trap by examining a drain, waste, and vent system whose trap has lost its seal. Diagnose and explain the cause and determine the appropriate solution, citing evidence from textbooks or technical manuals in order to justify why the chosen solution is preferable or more effective than another. (TN Reading 1, 2, 4, 5; TN Writing 2, 9; NCCER 02111-12)

Water Distribution Systems

24) Study a schematic plan of a typical municipal water distribution system. Citing evidence from a technical description or actual observation of a system, explain how water travels from a water treatment plant to a fixture in a residence. Create a graphic illustration to represent the movement of water from one component to the others in the system. For example, sketch an isometric drawing of a simple water distribution system and label its components. (TN Reading 1, 2, 3, 4, 7; TN Writing 2, 9; NCCER 02112-12)

Basic Maintenance & Repair Process

25) Identify and demonstrate basic troubleshooting strategies appropriate for evaluating plumbing systems and devices. For example, in a drain system, develop and implement a troubleshooting strategy to test and remedy a clogged drain. (TN Reading 3)

26) Identify routine maintenance procedures that should be performed on plumbing systems for a given building. Create a timeline of recommended maintenance procedures for a client, justifying why each procedure is necessary by highlighting its preventive or cost-efficient characteristics. For example, create a schedule of items to inspect and clean in order to keep a water heater running efficiently. (TN Reading 2, 3, 4, 7; TN Writing 4)

Green Practices in Plumbing

27) Define the term *efficiency* in the context of the plumbing profession and plumbing systems. Research and identify strategies used in the design of plumbing systems and plumbing work practices to increase the efficiency of plumbing systems. Drawing on resources such as those from the U.S. Green Building Council and EPA Energy Star, create a recommendation for a client outlining green plumbing strategies for a given building. (TN Reading 2, 3, 4, 7, 9; TN Writing 2, 7, 8; TN Environmental Science 5)

Business & Project Management

28) Describe the components and purpose of a basic contract document for a residential project, determining the meaning of key terms and other industry-specific words. Recognize the relationship and responsibilities of various parties to a contract. Write a basic contract for a job, such as a plumbing service agreement for work done for a residential client. (TN Reading 2, 3, 4, 5; NCCER 44105-08)

29) Establish and implement specific goals to manage project assignments in a timely manner, including organizing teams to effectively manage assignments, monitoring and reporting on project progress, and evaluating a completed project according to client requirements. For example, inspect and critique a team member's work, providing constructive feedback for improvement. Similarly, respond to constructive feedback from a team member to improve project outcomes and meet project goals. (TN Reading 2, 6; TN Writing 2)

30) Interpret construction drawings and applicable local plumbing codes to determine the correct materials, tools, and equipment needed to complete a plumbing project. Plan and implement the steps needed to complete the project, adhering to inspection procedures and employing safe practices throughout. Draw from print and electronic examples to create a material list, cost estimation, project schedule, and inspection checklist for a project, applying the components of the documents to the given project. (TN Reading 2, 3; TN Writing 4)

31) Produce clear and coherent writing for communication in the plumbing industry. Create a service order for a given plumbing project. Explain the service order to a peer, as would a service technician to a client. (TN Writing 4)

32) Utilize technology to write and share periodical reports (weekly, monthly, etc.) to provide others with information about progress during plumbing projects as would a project manager to a supervisor. Summarize activities in a narrative form including overall progress in relationship to a previously planned schedule. (TN Reading 3; TN Writing 2, 4, 6, 10)

Portfolio

33) Update materials from coursework to add to the portfolio started in *Fundamentals of Construction* and *Mechanical, Electrical, & Plumbing Systems*. Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses. Include photographs or illustrations and written descriptions of sequential progress in construction projects. (TN Writing 2, 4, 5, 6)

Standards Alignment Notes

*References to other standards include:

- TN Reading: Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standard 10 at the conclusion of the course.
- TN Writing: Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standard 3 at the conclusion of the course.
- TN Math: Tennessee State Standards for Mathematics; Math Standards for High School: Number and Quantity, Geometry (pages 58-83).
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students who are engaging in activities listed above should be able to demonstrate quantitative and geometric reasoning as applied to specific technical concepts. In addition, students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- TN Chemistry I: Tennessee Science: Chemistry I standard 2 may provide additional insight and activities for educators.
- TN Physics: Tennessee Science: Physics standard 2 may provide additional insight and activities for educators.
- TN Physical Science: Tennessee Science: Physical Science standards 1 and 2 may provide additional insight and activities for educators.
- TN Environmental Science: Tennessee Science: Environmental Science standard 5 may provide additional insight and activities for educators.
- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for NCCER Plumbing Level One and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.